

THE UNIVERSITY OF KANSAS SCIENCE BULLETIN

VOL. XXXVI, PT. I]

JUNE 1, 1954

[No. 9

Additions to the Known Herpetological Fauna of Costa Rica With Comments on Other Species. No. I.

BY

EDWARD H. TAYLOR

ABSTRACT: The paper treats of 19 species of Costa Rican amphibians. Five new species described are *Bolitoglossa alvaradoi*, *Bolitoglossa arborescendens*, *Oedipina alleni*, *Hyla manisorum*, and *Hyla weyeræ*. The species *Hyla richardi* Taylor (*non* Baird) is renamed *Hyla richardtaylori*.

The following are reported for the first time in Costa Rica: *Leptodactylus labialis*, *Leptodactylus bolivianus*, *Hyla rosenbergi*, *Hyla staufferi*. The species *Eleutherodactylus florulentus* known from a mutilated specimen is redescribed from a perfect specimen.

INTRODUCTION

Since the summer of 1947 I have been engaged in a study of the herpetological faunas of the Central American country of Costa Rica. This study has been based largely on collections made by Richard Clark Taylor and myself during the summer of 1947, and on a collection made by me in the summer of 1951. From these collections several publications have resulted, dealing with the salamanders, frogs, toads, and cecilians.*

In 1952, thanks to the kindness of the University of Kansas Endowment Association, funds were made available for a continuance of the work in Costa Rica. I reached Costa Rica on June 5 and collecting began June 6. With Mr. John Baker of Turrialba, Costa Rica as an able assistant, intensive collecting was continued until September 19 of the same year. A total of more than 4,000 herpetological specimens was acquired representing approximately 280 species and subspecies.

* (1) Costa Rican frogs of the genera *Centrolene* and *Centrolenella*. (2) Two new Teiid lizards from Costa Rica. (3) New salamanders from Costa Rica. (4) Two new genera, and a new family of tropical American frogs. (5) A brief review of the snakes of Costa Rica. (6) The salamanders and caecilians of Costa Rica. (7) The frogs and toads of Costa Rica. (See bibliography for place and date of publications.)

The parts of the country visited included many localities in which I had collected previously, as well as several that were new. Some time was spent in the Province of Guanacaste on the drier western part of the country, and in the wet southern part of the Province of Puntarenas, a region with an annual precipitation reputedly in excess of any other part of Costa Rica. Here we found several species not taken in the previous collections, certain of which were new to the known fauna. During the summer we were successful in acquiring representatives of numerous species previously represented by a single type or at most very few specimens, and certain ones that are new species.

It is a matter of regret that it has not been possible to pursue collecting in the winter and spring months, since I feel sure that forms of amphibians that breed at other times than the summer may still be wanting in collections.

Greater effort was made to obtain representatives of lizards on the 1952 journey. A number of species of anoles and geckoes were taken, not previously represented in my collecting, as well as certain species of teiids and iguanids likewise not taken before.

A few species of snakes, not met with before were encountered or were added to the collections through the kindness of friends, or through the medium of exchanges.

The principal places visited were as follows:

1. Turrialba and its general surroundings in the lower eastern part of the Meseta Central.
2. Moravia (de Chirripo) on the eastern slope of the Talamanca Mountain Range.
3. Cariblanco, at an elevation of about 800 M., north of the east-west range of volcanoes.
4. Cinchona (formerly American Cinchona Plantation) on the southeastern drainage of Volcán Poás.
5. Volcán Barba.
6. Peninsula of Puntarenas and region about its base.
7. Western slope of the Meseta Central.
8. Tenorio, the great cattle ranch of the United Fruit Company on the southwestern slope of the Cordillera del Guanacaste, extending to the slopes of Volcán Tenorio.
9. Pan-American Highway from Cartago, in the Meseta Central, to San Isidro del General (715 M.) on the western slope of the Talamanca Range, crossing the Talamanca Range on Cerro de la Muerte at an elevation of 3,300 M.

10. Palmar. Banana country near the western coast in the southern part of the province of Puntarenas.
11. Golfito. Banana country on the Golfo Dulce, near the extreme southeastern part of Costa Rica, Province of Puntarenas.
12. Limón on the Atlantic Coast.
13. La Lola, eastern lowlands.
14. Guápiles and Los Diamantes in the eastern lowlands.

ACKNOWLEDGMENTS

In 1951 and 1952, Dr. Ralph Allee the Director of the Inter-American Institute of Agriculture at Turrialba made me welcome at that Institution and permitted me to use it as a base for collecting in the country. In many ways he and the staff of the Institute furthered my efforts. In 1953 I was able to obtain the much appreciated assistance of Mr. John Baker, whose father is an official of the Institute. I found John a helper of more than ordinary interest and abilities, who ably shared with me all of the vicissitudes of mountain and jungle collecting.

Mr. John Reark, a student at the Institute and Dr. Leslie Holdridge of the Bureau of Agriculture likewise were of much assistance in 1951. I am under deep obligation to Sr. Guillermo Esteves for very numerous photographs in color of living specimens.

To Lic. Oldemar Chavarria Ch., Mr. John Reark, Dr. Leslie Holdridge, Sr. Marco Tulio Pacheco, Sr. Don Juvenal Valerio and his son Sr. Julio Valerio, Mr. Paul Allen, and Mrs. Albert Weyer, I offer my thanks for the gifts of numerous splendid specimens.

For extended hospitality I offer my sincere thanks to Sr. Don Fernando Alvarado-Chacón, Mr. and Mrs. John Stelzer of Tenorio, Mr. and Mrs. Paul Allen of Palmar, Mr. and Mrs. Eugene Manis of Los Diamantes, Sr. Alfredo Echandi and Sr. Alberto Echandi of Cariblanco, Sr. Don Rubén Torres Rojas of Cartago, Mrs. Greening, my official hostess at the Compania Bananera installation in Golfito, and Prof. Don José Bustamante of Cinchona.

I am greatly indebted to the officials of the United Fruit Company for permitting me to visit various parts of their plantations, for transportation, and for extended hospitality.

The following persons have contributed to the expedition in various ways: Mr. Heino Itter, specimens; Mr. Leon Smith, transportation; Mr. Donald Fiester, specimens; Sr. Luis Siller, specimens; Sr. Victor Muñoz, Sr. Alfonso Trejos of the Hospital San Juan de Dios, specimens; Mr. Curtis Good, specimens; Sr. Don Jorge Ulloa, Mr. M. L. Harshberger.

This paper treats of the following amphibians:

	PAGE
<i>Bolitoglossa arborescandens</i> sp. nov.	600
<i>Bolitoglossa lignicolor</i> (Peters)	603
<i>Bolitoglossa alvaradoi</i> sp. nov.	604
<i>Chiropterotriton abscondens</i> Taylor	607
<i>Oedipina alleni</i> sp. nov.	607
<i>Leptodactylus quadrivittatus</i> Cope	610
<i>Leptodactylus labialis</i> Cope	613
<i>Leptodactylus bolivianus</i> Boulenger	617
<i>Eleutherodactylus florulentus</i> Cope	620
<i>Hyla moraviaensis</i> Taylor	622
<i>Hyla staufferi</i> Cope	623
<i>Hyla richardtaylori</i> nov. nom.	624
<i>Hyla alvaradoi</i> Taylor	625
<i>Hyla boulengeri</i> Cope	625
<i>Hyla wellmanorum</i> Taylor	626
<i>Hyla rosenbergi</i> Boulenger	626
<i>Hyla manisorum</i> sp. nov.	630
<i>Hyla weyeriae</i> sp. nov.	633
<i>Rana palnipes</i> Spix	635

Bolitoglossa arborescandens sp. nov.

Figure 1

Type: K.U.M.N.H. No. 34925 ♂; collected Aug. 16, 1951, Moravia de Chirripo, Limón Province, Costa Rica, by Edward H. Taylor.

Diagnosis: A rather slender species with webbed feet and costal grooves deeply cut and directed diagonally backward (except those in axilla and groin); head relatively narrow, its width, in length from snout to end of vent (9 mm: 65 mm.) 7.2 times; head length (13 mm.) in same, 5 times; adpressed limbs separated by approximately 1.5 costal folds; tail about 87 percent of distance from snout to end of vent; olive green above with sparse, deep-black dots; black on ventral surfaces; (green disappearing in preservative).

Description of type: Snout sharply truncate, the nostrils less than their diameter from the anterior tip of snout; canthal area rounded, the loreal region slightly convex; eyes moderately elevated, the distance between (4 mm.) twice (or a little less than) width of the eyelid; a very indistinct wide groove runs from behind eye, curves down toward jaw angle, joining a transverse groove arising slightly above the junction and passes across the throat in a somewhat sinuous line; the nuchal groove arises on side of neck, curves back slightly and passes across the throat bordered by a fold; the epibranchial cartilage forms an elevated ridge passing above arm

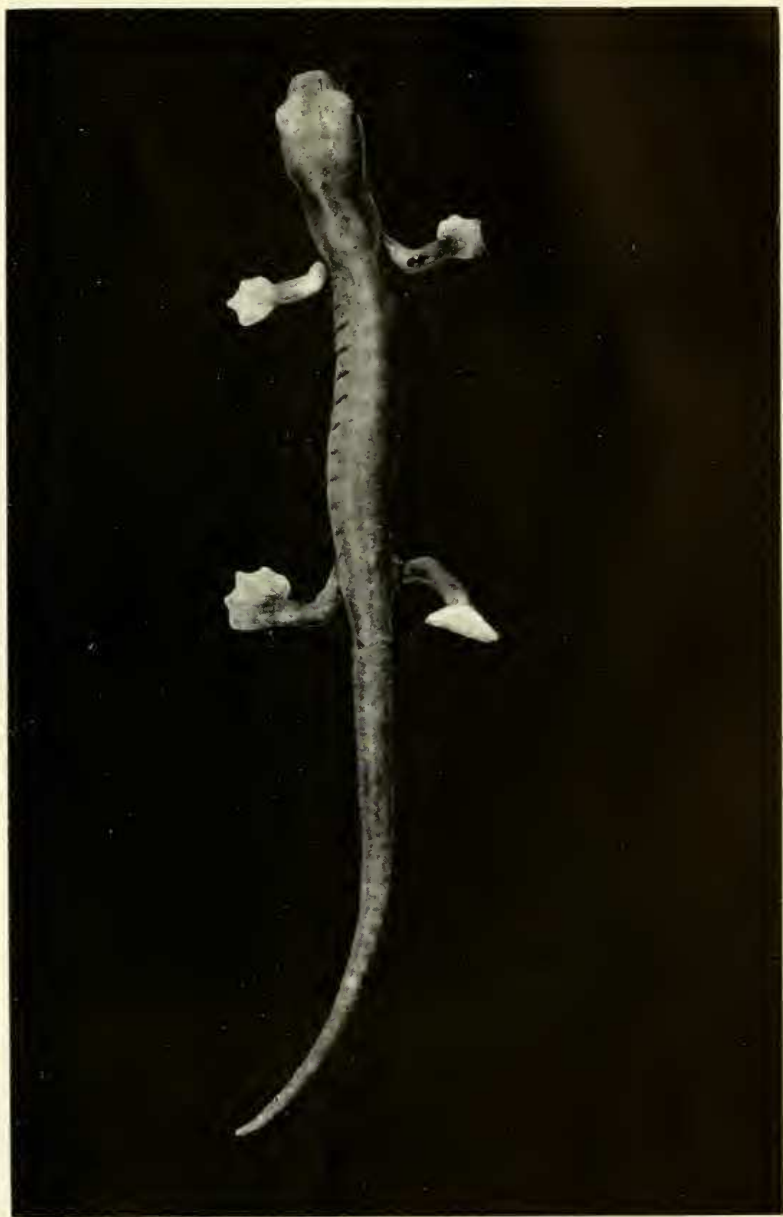


FIG. 1. *Bolitoglossa arborescens* sp. nov. Type. K.U.M.N.H.
No. 34925 ♂. Actual total length, 124 mm.

but not crossing completely the first costal fold; mental hedonic gland-cluster conspicuous, the individual glands gray white separated by dark reticulation; on front edge of lip below nostrils two pendant conical tubercles, their frontolateral faces bisected by the oronasal groove; a small diagonal skinfold behind angle of eye; length of eye equal to its distance from nostril; two large premaxillary teeth penetrate the lip (but apparently others now missing are normally present).

Maxillary teeth 38-38 (counting missing teeth); mandibular teeth 50-51; paravomerine teeth (90-90) in two groups with only a slight division between; tongue bolitoglossoid without any trace of a sublingual fold; choanae small.

Arm brought forward, the fingers do not reach the tip of lower lip; fingers webbed, the border slightly emarginate between digits; legs rather long, the toes completely webbed; the edge of web slightly emarginate between toes; the postfemoral glandular spot present but scarcely discernible; tail 86 percent of the snout-vent length, rather circular in cross section, slightly constricted at base; about 29 caudal folds can be discerned, the terminal part of tail seemingly undifferentiated, none or only a faint trace of a subcaudal groove; costal folds on body 12, with 13 costal grooves counting one each in axilla and groin; when limbs are adpressed they are separated by approximately one and one-half costal folds. Skin on head, under a lens, pitted distinctly; on tail, under a lens, one discerns a reticulum like a fine honeycomb, marking the individual glands, conspicuous on ventral and lateral sides of tail.

Color in life: Lively olive-green with a scattering of tiny black dots on head and body, the color extending down on sides; venter, lower part of sides, limbs, underside of head and neck, deep black. In preservative the green has disappeared and the entire dorsum is black. Under clear liquid, in strong light, the tiny black spots can still be discerned.

Measurements in mm.: Total length 124; snout to end of vent, 65; tail 59; snout to arm 19; axilla to groin 35; width of head 9; length of head 13; arm 15.2; hand 5.5; leg 16; foot 6.6.

Remarks: This specimen was taken from a bromelia in a large, recently felled forest tree. I am unable to suggest its closest relative. It occurs with at least two other species of the genus at Moravia de Chirripo—*Bolitoglossa alvaradoi* and *B. colonnea*. Another species *B. striatula* occurs at Turrialba, a region of like climate and elevation, and this also may occur at Moravia de Chirripo.

Bolitoglossa lignicolor (Peters)

Spelerpes (*Oedipus*) *lignicolor* Peters, Monatsb. K. Akad. Wiss. Berlin, 1873, p. 617 (type locality Chiriquí, Panamá); Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 734-735.

Collections in 1951 and 1952 resulted in the discovery of only a single large specimen of this species at San Isidro del General (K.U.M.N.H. No. 34924).

This specimen agrees with the type description save that it is considerably larger, measuring 155 mm. in total length. The length, from snout to end of vent, being 77 mm., the tail 78 mm. The width of the head (11 mm.) is contained in distance between snout and end of vent, 7 times; the head length (14 mm.) into the same distance 5.5 times.

In the type the width of the head is contained some five times in this distance ("etwa fünfmal in der Entfernung der Schnauzenspitze von der Analöffnung enthalten."). It would appear that the head width does not increase proportionally with body length. The measurements of the type are included in parentheses with measurements of this specimen. Total length 155 (100); snout to end of vent 77 (49+); tail 78 (48); snout to arm insertion 22 (17); axilla to groin 43.5 (29); arm 17 (12); hand 5.7 (4); leg 16 (13.5); foot 7.2 (5).

The color from snout to tip of tail is yellowish brown, flecked or marbled with darker pigment, which may unite to form somewhat larger flecks or indistinct short lines. The lower half of the sides are darker gray, the chin and venter having numerous cream or yellow, somewhat linear marks. The limbs are blackish, and the tail is mottled in dark gray, the cream marks showing a slight pinkish wash.

Peters does not give specific data on the dentition of his type. In my specimen the paravomerine teeth are in a single patch consisting of approximately 204 teeth; the maxillary teeth are 23-25; the mandibular 40-40; vomerine teeth 13-14 in two curving series rather widely separated mesially, each arranged in a single series beginning beyond outer level of choanae. Only three premaxillary teeth are present and these are larger than the maxillary teeth but are in the tooth line. There are 13 costal grooves more or less distinct, and 12 folds. The adpressed arms and legs are separated by $3\frac{1}{2}$ folds. The feet are much broader than the hands. The interorbital space is about $2\frac{1}{4}$ times the width of an eyelid. The length of the eye is somewhat less than its distance from the nostril.

I have considered the possibility that *B. palustris* Taylor might be a young specimen of this species. However the characteristics—vomerine teeth forming an irregular patch on strongly elevated ridges (low in *lignicolor*), the domelike character of the palate (much less so in *lignicolor*), and the choanae of the type actually larger than those of this specimen of *lignicolor*, more than double its size, the tail compressed, higher than wide, the color different—all point to a distinct species. I think it most unlikely that these differences could be due to age.

Bolitoglossa alvaradoi * sp. nov.

Figure 2

Type: K.U.M.N.H. No. 30484 ♀; Collected at Moravia de Chirripo, Limón Province, Costa Rica, Aug. 16, 1951, by Edward H. Taylor.

Paratypes: K.U.M.N.H. Nos. 34903, 34904, June 26, 1952; No. 34905, June 25, 1952; all from Moravia de Chirripo; same collector.

Diagnosis: A rather large arboreal salamander, with 13 moderately distinct costal grooves, transverse rather than diagonal; the width of head, in the length, snout to end of vent (13 mm; 77 mm.) approximately six times; head length (15.6 mm.) in same length, approximately 4.9 times; adpressed limbs separated by approximately three costal folds; body black with blotches of pinkish fawn or cream, sometimes the color more or less generally distributed; limbs, front of head, and tail terminus black; tail equal or minutely less in length than distance from snout to end of vent. Foot and hand almost completely webbed.

Description of type: Snout truncate, the nostrils separated from the tip of the snout by a distance equal to diameter of nostril; snout flattened, the canthus not indicated, the loreal region not convex; eyes slightly elevated, the interorbital distance twice width of an eyelid; no distinct longitudinal groove behind eye; a transverse groove beginning somewhat above the level of the mouth passes over the back part of jaws and crosses the throat; a nuchal groove arising on the side of the neck passes across throat forming a groove bordered by a free flap one and one-half millimeters wide; the epibranchial cartilage forms a strong fold on the side of neck, passing above arm as far as the beginning of the second costal fold; female without mental hedonic gland (present in males); on lip a small swelling below the nostril with the oronasal groove bisecting

* Named for Don Fernando Alvarado Chacón owner of Moravia de Chirripo.

its frontolateral surface; a distinct diagonal skinfold behind angle of eye.

Eight tiny premaxillary teeth lying within the normal curve of the maxillary tooth row; maxillary teeth approximately 44-45; mandibular teeth 58-59; paravomerine teeth in two closely approximated



FIG. 2. *Bolitoglossa alvaradoi* sp. nov. Type. K.U.M.N.H.
No. 30484 ♀. Actual total length, 152 mm.

groups (very narrowly separated by a toothless line), numbering approximately 146-142 in the two groups; vomerine teeth in two somewhat irregular elevated rows beginning outside of the choanal level, and curving in and backward, 15 on left side, 11 on right (beginning within the inner level of right choanae [abnormal]); tongue bolitoglossoid, without a sublingual flap.

Arm brought forward the fingers fail considerably to reach tip of lower lip; fingers almost completely webbed, the third longest with emarginations in outline between each two fingers; legs relatively large, toes completely webbed with emarginations in outline between each two toes; postfemoral gland present; tail almost as long as snout-to-vent measurement, constricted at base, slightly compressed laterally and higher than wide; a subcaudal groove more or less indicated; 33 caudal grooves; body with 13 costal grooves and 12 costal folds, counting a groove in axilla and groin; when limbs are adpressed they are separated by approximately three costal folds; under a lens, top of head distinctly pitted.

Color in life: Above with a blackish-brown ground-color, with rosy-clay or fawn markings covering most of dorsal surface of head, body and tail; chin and throat brownish black; lower part of sides, ventral surface of body and tail purplish black. In preservative the pinkish shade is lost; venter blackish brown; ventral side of tail bluish black.

Measurements and data of Bolitoglossa alvaradoi sp. nov.

Number	30484	34903	34905	34904
Sex	♀ Type	♂	♂	♂
Total length	152	129	..	106
Snout to end of vent	77	65	62.5	57
Tail	75	64	..	49
Snout to arm	22.3	19	18	17
Axilla to groin	43	37	35	32
Arm	17	15	14.6	12
Hand	8	6	5.8	4.9
Leg	19	15	15	14
Foot	8	7	6	5
Premaxillary teeth	8	5	6	6
Vomerine teeth	11-15	15-13	14-11+	15-15
Maxillary teeth	44-45	44-44	33-37	36-41
Mandibular teeth	58-59	53-54	45-50	48-49
Paravomerine teeth	146-142	138-132	92-84	132-120

Variation: The notes on color of the various paratype specimens are as follows:

No. 6523. "Body reddish brown and black above forming island-

like areas; bronzy gray-black below; legs, back and under tail deep black." No. 6524. "Same as above"; No. 7040. "Dark red-brown with salmon flecking above on black ground color; blackish below; a very irregular median black line."

Chiropterotriton abscondens Taylor

Figure 3 (left)

Chiropterotriton abscondens Taylor. Proc. Biol. Soc. Washington, vol. 61, Nov. 12, 1948, pp. 177-178 (type locality Isla Bonita, [American Cinchona Plantation] elev. 5,500 ft., Volcán Poás, Costa Rica); and Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 702-704, text fig. 1.

By accident we discovered in 1952 the major habitat of this small form on the slopes of Volcán Poás. We had been searching for *Magnadigita subpalmatus* on the old road-cuts near Cinchona where in 1947 my son and I had collected a series of 43 specimens. Using the same technique at night that had been employed before, we found not a single specimen. We knew they must be there so in daylight we uprooted the thick beds of moss on these road-cut surfaces and shook them out on the road bed. A series of 20 specimens of *Chiropterotriton abscondens* was thus obtained, together with four other species of salamanders, none of which was *Magnadigita subpalmatus*!

The specimen figured is typical.

Oedipina alleni * sp. nov.

Figure 3 (right)

Type: K.U.M.N.H. No. 34926 ♀. Collected at Palmar, Puntarenas Province, Costa Rica, Sept. 2, 1952 by Edward H. Taylor.

Diagnosis: A diminutive salamander, with 18 costal grooves and 17 costal folds; maxillary teeth reduced to 2 on each side; 2 premaxillaries; paravomerine teeth in a single patch of about 110 teeth; vomerine teeth 5-7; a few mandibular teeth, probably less than ten; choanae large, not widely separated; no longitudinal groove behind eye; arched lines or grooves on chin absent; adpressed limbs separated by about 7 costal folds; tail higher than wide. Head largely cream color; body variegated with cream and brown, becoming cream or fawn on tail; a dark stripe along side of head, body, and tail. Chin white, venter grayish.

Description of type: Snout oval in profile, the length distinctly greater than length of eye; top of snout curving transversely to lip;

* Named for Mr. Paul Allen my host at Palmar and my field companion when the species was discovered.

canthus rostralis not indicated; width of an eyelid a little more than half the interorbital distance; surface of occipital region smooth, without evidence of muscle outlines; a transverse groove behind eye crosses the jaws and passes across throat, curving slightly back mesially, but the lines or grooves normally arching forward on chin

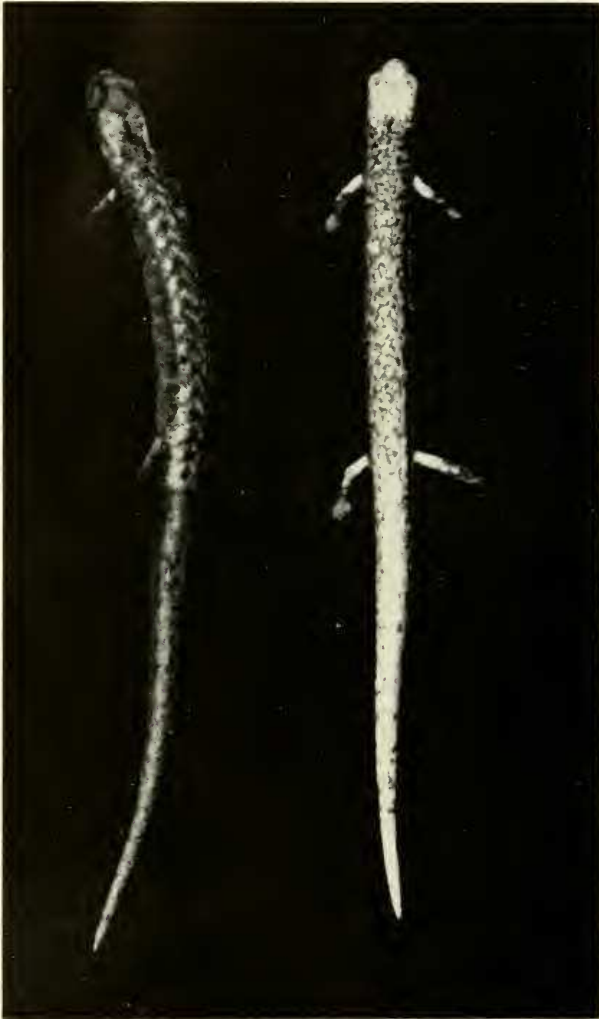


FIG. 3. Left. *Chiropterotriton abscondens* Topotype, K.U.M.N.H. No. 34935. Actual total length 71 mm. Right. *Oedipina alleni* sp. nov. Type, K.U.M.N.H. No. 34926 ♀. Actual total length 66 mm.

seemingly absent; nuchal groove begins near dorsal surface of body, passes down, curving forward, crosses neck in a convex curve bordered by a slight nuchal skinfold; snout rather strongly projecting beyond mouth; nostrils minute, the oronasal groove leaves nostril and runs down and back to a slight labial swelling on lip, distinctly posterior to level of the nostril. Tongue bolitoglossoid, not close to front of mouth, with a curving sublingual fold; vomerine teeth 5-7 on very low ridges, which curve back, the series not reaching outer level of choanae; latter large, separated by a space equal to $2\frac{1}{2}$ times diameter of a choana; at least two teeth on maxillae opposite choanae; at least two premaxillary teeth; at least 5 mandibular teeth on each side; the palate posterior to the vomerine ridges, flat; para-vomerine teeth separated widely from vomerine teeth; latter minute (probably less than half as large as in specimens of other species, having the same snout—vent length.)

Arm very short not reaching posterior angle of mouth; fingers four, nearly fully webbed, the third pointed with the tip free, the hand spread out flat; feet spread, the tips of the three middle fingers slightly projecting from web, the middle one with a rounded point; limbs adpressed, the digits separated by about 7 costal folds; 18 costal grooves counting one each in axilla and groin, and 17 costal folds, the last not strongly defined. Tail seemingly not constricted at base, but laterally compressed; about 28 caudal folds.

Color: Head cream-white on top, the eyelids bluish white; ground color of body cream, heavily speckled with brown, growing less dense and nearly cream on tail; a dark stripe from tip of snout along side of head and body to tip of tail; chin with a large cream area, the venter and under side of tail, with minute brownish reticulations which enclose cream dots; upper arm and leg lighter than lower part of limbs; postfemoral glandular area not, or very indistinctly visible; cloacal walls striate.

Measurements in mm.: Total length 66; snout to end of vent 34; tail 32; snout to foreleg 9; axilla to groin 21; head width 4; head length 5; arm 5.2; hand 1.5; leg 5.6; foot 2.1.

Remarks: The relation of this species is probably with *O. parvipes*. That form differs from this in having narrow pointed toes, the presence of 16-18 maxillary teeth, the submental grooves present and different color and markings. Dunn states that *parvipes* has a "sharp snout" and the tail is nearly twice head-body length.

Leptodactylus quadrivittatus Cope

Figure 4

Leptodactylus quadrivittatus Cope, Proc. Amer. Philos. Soc., vol. 31, 1893, p. 339 (type locality, Buenos Aires, Costa Rica).

In my review of the Costa Rican frogs I had at hand no specimens of *Leptodactylus quadrivittatus*. In 1952 Mr. John Baker and I found the species occurring commonly in the southwestern part of Costa Rica in the region of heavy rainfall at Palmar and Golfito and considerable series were taken. Specimens were breeding at this time and numerous egg masses were found under trash (cut grass or matted growing weeds in swampy areas) or under logs or rocks in wet meadows.

The eggs, mixed in masses of foam, were in small excavations in the earth. The eggs, lacking all trace of dark pigment, were yellowish cream (sometimes an orange cream) the foam itself likewise being creamy in color.

The following numbers are in the collection. From Palmar Nos. 32317-32331; Golfito, 32332-32375. These specimens are in two different forms which may be readily separated by pattern and color; a median fawn or light brown stripe being present in one form. Those bearing the stripe from Palmar are Nos. 32317, 18, 22, 23, 26, 28, 29, 30, 31; those lacking the stripe are 32319, 20, 21, 24, 25, 27. From Golfito Nos. 32332-32359 are striped; Nos. 32360-32375 lack the stripe. Males and females are approximately equal in the series, and about equally divided in the two forms.

The type from Buenos Aires, Costa Rica is of the lined type, and our specimens agree with the description save that there are four longitudinal ridges instead of two on the dorsum. Although Cope states, "Two stout glandular ridges on each side of the vertebral median line," no dorsolateral lines are mentioned. However, he contrasts the species with Boulenger's *longirostris* and mentions as a difference "and there are but two dorsal glandular folds." *i. e.*, in *longirostris*, thus suggesting that there were more in the type of *quadrivittatus*, since a pair in the middle of the back, a dorsolateral pair, and a third pair low on the sides are present.

The form lacking the stripe has the interorbital area narrower than the upper eyelid; the dorsolateral ridges arising and terminating almost exactly as in the striped form, but on the dorsum just back of the eyes there are two indistinct, somewhat elongate tubercles, and in the shoulder region an elevated inverted Y-shaped ridge on the shoulders. Behind this, extending onto rump

are irregular low tubercles variable in size; on the sides there is a small glandular skinfold running diagonally to the groin continuous or nearly continuous with the supratympanic ridge; this ridge sends a branch behind tympanum to above arm. A hair-fine median ridge is evident in both forms.



FIG. 4. *Leptodactylus quadrivittatus* Cope. Upper. K.U. M.N.H. No. 32327, unstriped form, Palmar, Costa Rica. Actual snout-vent length 405 mm. Lower. K.U.M.N.H. No. 32373, Golfito, Costa Rica. Actual snout-vent length 49 mm.

Males of both forms may be distinguished readily by the folds of skin at the sides of the chin marking the vocal sacs, and their internal openings, which are ample and somewhat posterior in position.

The tongue is free along much of its sides, as well as behind, and the median notch is present. In males the edge of the snout is somewhat flattened, forming a slight shelf having a very slight downward flare. It is rounded in females. The lateral skin-folds on the chin are usually pigmented with black. None of the specimens of the unstriped form show any trace of the four black stripes that run the length of the body nor the median fawn stripe. However within the limits of variation they have practically the same lateral head marks, supratympanic marks, similar black spots on front of thigh, on back of tibia, and a transverse white stripe bordered above by black on the posterior face of the thigh. The edge of the flap above vent has a tiny white mark. The characters of the feet, body proportions, ventral granulation of thigh, the ventral disc, and smoothness of the venter are characters common to both. These, taken with the fact that they were found together in the field as a single breeding population leaves the conclusion that only a single species is involved, and that the striped coloration and median dorsal skin folds are linked in inheritance, but they are not sex-linked.

The type described by Cope seems to have been a halfgrown specimen, since almost the entire breeding population exceeds the measurement of 37 mm. given by Cope for the type. I have measured a series of 14 striped specimens. Of these eight are females measuring between 48 and 51 mm. Six are males 45 to 48 mm. in length. Nine of the unstriped forms were also measured. Three females measure 47 to 51 mm.; 6 males measure from 44 to 48 mm.

It is probable that this species is related to *Leptodactylus poecilochilus* but the characters of the latter species seem to differ in a number of points. These are contrasted below, the data being from the type description.

"Color of superior surfaces chesnut brown, the sides rather darker, delicately marbled, next to the pure white abdomen."—The markings and color of both forms of *quadrivittatus* are different.

"Tympanum half the size of eye."—In *quadrivittatus* the tympanum is 3.5 mm. and the eye length 4.4 mm., thus much more than half eye length.

"Muzzle short not prominent"; the snout is 7.3 mm. long distinctly prominent, and not "short."

"Head rather depressed." The head definitely is not depressed.

"Vomerine teeth in two well-separated curved series behind the internal nares, the outer extremities of the former on a line with the middle of the latter." The vomerine teeth are in two elongate, slightly convex series closely approximated mesially and extending beyond outer (lateral) level of choanae.

"Heel extended reaches nostril." The tibiotarsal articulation extends beyond nostril.

"Toes not margined, slightly webbed at base;" I interpret the condition in *quadrivittatus* as without web.

The markings on the limbs are similar. However the difference in the size of the tympanum, the elongate muzzle, the character of the vomerine teeth, and the general difference in color would seem ample to differentiate the forms.

Leptodactylus labialis Cope

Figure 5

Cystignathus labialis Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 90 (type locality "Probably a part of Sumichrast's Mexican collection" made chiefly in southeastern Mexico, Veracruz, Oaxaca, and Chiapas, restricted by Smith and Taylor to Potrero Viejo, Veracruz).

Leptodactylus labialis Brocchi, Étude des Batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, pt. 3, 2nd sec. (1881-1883), livraison 1, 1881, p. 20. (no specimens; data from type description.)

Leptodactylus albilabris Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, art. 10, June 20, 1918, pp. 323-325 (discussion of mainland and Antillean forms; reports the species in Nicaragua).

Leptodactylus labialis Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 403-421. (Fort Sherman and Majagual, Canal Zone.)

This species has a considerable range. In 1932 I reported the species in southern Texas, its northern limit of distribution. Dunn has reported the form in the Canal Zone on Barro Colorado Island. It has been argued that this form may have been introduced into Puerto Rico, and since Noble, *loc. cit.*, knew of no other Central American records than his Nicaraguan specimens it did not seem impossible that it may have been introduced there and in Panamá, and that the distribution of *labialis* was actually discontinuous. I did not include it in my review of the frogs of Costa Rica.

However, the discovery of this species on the coastal region of western Costa Rica suggests that the distribution is continuous and its apparent absence from other suitable Central American areas is due to faulty collecting.



FIG. 5. *Leptodactylus labialis* Cope. Upper. K.U.M.N.H. No. 34544. Actual snout-vent length 34.8 mm. Lower. No. 34543. Actual snout-vent length 35 mm. Both from Barranca, Puntarenas, Costa Rica.

The specimens, (K.U.M.N.H. Nos. 34543-34547), obtained by John Baker and myself the night of July 27, were hopping about on the rocky banks of a small rivulet in the general region of Barranca, Puntarenas Province, Costa Rica. Another series (K.U.M.N.H. Nos. 34548-34552) was taken by us at Tenorio, Las Cañas, Guanacaste, Costa Rica, August 21, 1951 in a small swampy area in pasture land, where springs kept standing water in hoof tracks on the closely cropped ground. These latter specimens were calling at night but there was no evidence that they were breeding at this time.

Diagnosis: A small leptodactylid, the females reaching a length of 38 mm., male, 32 mm. in Costa Rican specimens. Male without two horny spines on inner surface of first finger; a pair of vocal sacs indicated on chin by a pair of regular folds; first finger longer than second; a ventral "disc" present; an indistinct, more or less continuous, dorsolateral and a lateral fold or longitudinal series of glandular tubercles; tibiotarsal articulation to eye; males with a small shelflike extension of the sides and tip of snout. Length of tympanum about three fourths of the length of eye; dorsally brownish gray with black spots, flecks, or indefinite lines; below white.

Description of species: (From K.U.M.N.H. No. 34543). Body rather flat, the head also depressed, the eyes small, moderately prominent, canthi absent, the canthal areas rounded; the lores sloping, slightly concave between nostril and eye; nostril a little closer to eye than to median point on upper lip; length of eye (4.2 mm.) greater than distance between eye and nostril; distance between nostrils (3 mm.) a little greater than interorbital width (2.8 mm.); tympanum a little longer than high, its greatest diameter (3.1 mm.) less than eye length (4.2 mm.); distance between tympanum and eye slightly more than half greatest diameter of eye; a well-defined supratympanic fold runs straight back from eye, then bends down behind tympanum and continues to arm, while an enlarged glandular tubercle, running back from tympanum to arm, is separated from it by a groove; a glandular area outlined behind the tympanum (better developed in male than female); the vocal sac is evident as a well-defined skinfold on each side of the chin and throat.

Tongue subcircular, unemarginate behind, the posterior fourth or fifth free; choanae small, widely separated, rounded, the diameter of one contained in the distance between them about five times; vomerine teeth in two curving transverse elevated series, the elevations narrowly separated mesially and lying much behind posterior level of choanae; arm short, brought forward the wrist

fails to reach the tip of the snout; no digital webs, but some of the fingers with lateral ridges; first finger longer than second; second and fourth about same length; distal subarticular tubercles small or obsolete, proximal tubercles large on three inner fingers; four supernumerary tubercles on palm; a strong elongate flattened inner metacarpal tubercle, and an equally large, or larger, palmar tubercle; (male without trace of spines on first finger); toes lacking digital webs or fringes; practically no trace of lateral ridges on digits except near tips; subarticular tubercles strong except distal ones which are obsolete; sole and under surface of tarsus with numerous granular tubercles; a small inner metatarsal tubercle and a smaller distinct outer tubercle; inner tarsal fold indicated by a continuous row of white tubercles; no outer fold.

Skin of head nearly smooth; on back and sides finely corrugated with a nearly continuous dorsolateral skin fold or ridge; sides with irregular tuberculation with one conspicuous row tending to form a longitudinal fold midway on side. A shield-shaped "disc" distinctly outlined on venter; chin, venter, and under arms glassy smooth; the median and posterior thigh region granular, the granules extending somewhat onto the posterior surface of thigh and below vent; a few pearly tubercles on the tibia; tibiotarsal articulation reaches to the eye.

Color: Above brownish gray, the tip of snout lighter gray; a pair of black lines begin on tip of snout and extend to eye (partly broken); a dark line borders lower edge of the supratympanic fold; tympanum brownish, pigmented; a pair of blackish blotches above eyes, more or less joining mesially, extend back narrowing posteriorly; a milk-white median spot just behind shoulders usually preceded or partly surrounded by a darker mark; legs banded with dark olive or brownish black; back of thigh flecked and spotted, with an indefinite, cream-colored, transverse line. Chin, venter, and underside of arms white; some darker flecks under thigh.

Measurements in mm.: Snout to vent, 35; head width, 12; head length, 12.7; arm, 17.2; leg, 52.3; tibia, 17; foot and tarsus, 27.

Variation: There is not much significant variation, except that due to sexual dimorphism, in the Costa Rican specimens. In life they vary somewhat in ventral coloration some being more or less yellowish or yellowish flesh on thighs. Certain specimens from Tenorio have a pinkish color on thighs. The blackish areas are often olive in life.

The genus *Leptodactylus* is in need of revision. The extraordinary modifications of the male first finger in certain species in the genus, strongly suggests that a generic split is warranted.

Leptodactylus bolivianus Boulenger

Figure 6.

Leptodactylus bolivianus Boulenger, Ann. Mus. Genova, ser. 2, vol. 19, p. 131 (type locality Bolivia).

A series of specimens K.U.M.N.H. Nos. 32292-32304, collected at San Isidro del General, Palmar, and Golfito have been referred to this species, originally described from Bolivia. South American material available for comparison has been scanty and it may well be that subspecific differences obtain. As the species was unknown to me as a member of the Costa Rican fauna it did not appear in my "Review of the Frogs and Toads of Costa Rica." In consequence I present a description of the species.

Diagnosis: A large species attaining a size of 105 mm. (in Costa Rica my largest specimen, from San Isidro del General, measure 90 mm.). the habitus typically ranalike; a pair of dorsolateral glandular ridges with a lateral ridge running from eye distinct and more or less continuous; snout elongate rather pointed; males with a pair of short conical horny tubercles on inner surface of first finger; fingers and toes unwebbed the toes with very narrow lateral dermal fringes; a strong inner tarsal fold; arms of males greatly thickened; heel to front of eye; a strongly defined ventral disc.

Description of species: (K.U.M.N.H. No. 32292 ♀). Length of head (33 mm.) distinctly greater than width (29 mm.), oval in outline; eyes large, moderately elevated, its length (8 mm.) equal to its distance from nostril, less than length of snout (12 mm.), nostril much closer to median point on upper lip than to eye; interorbital width (5 mm.) distinctly less than width of an eyelid; snout sloping obliquely down in front of nostrils, extending beyond lip (2 mm.); canthus absent, the loreal region with a longitudinal depression. Tympanum longer than high (6 mm. x 5.4 mm.) the upper edge overhung by a strong fold from eye that continues to groin, separated from eye by a distance of 3.5 mm.; a longitudinal gland at jaw angle; tongue elongate (21 mm.), its width 15 mm., free behind for 7 mm., free on sides to a lesser extent; distance between choanae (7 mm.) a little more than three times diameter of a choana; palatal glands open into a sinuous groove near anterior part of palate, whose ends turn back on each side of palate toward

choanae; vomerine teeth on two strongly elevated bony prominences, the teeth on their posterior edges in an inverted V-shaped group closely approximated mesially, behind choanae reaching laterally beyond inner edge of choanae; arm brought forward the wrist fails to reach tip of snout; fingers unwebbed, the inner edges of the second and third fingers with ridges (covered with fine thorny spicules in males); subarticular tubercles large; a large inner metacarpal tubercle and a bifid outer metacarpal tubercle; first finger distinctly longer than second; (in male first finger with a short horny conical tubercle placed beside subarticular tubercle and an-



FIG. 6. *Leptodactylus bolivianus* Boulenger. K.U.M.N.H. No. 32293, Golifito, Costa Rica. Actual snout-vent length, 91 mm.

other on forward end of inner metacarpal tubercle); arm of male, at insertion, double diameter of female arm.

Legs folded at right angles, heels overlap about 2 mm.; tibiotarsal articulation to the front edge of eye; toes elongate, pointed, without basal web but with narrow lateral dermal fringes; subarticular tubercles rather small; a small inner and a very small outer metatarsal tubercle; a strongly defined tarsal fold.

Skin very minutely corrugated; a pair of complete dorsolateral folds; a diagonal fold from eye to groin, with a small branch running behind tympanum; a row of warty tubercles above and below this fold. Skin of sides indefinitely granular; upper surface of femur and tibia with fine tubercles sometimes forming rows or fine ridges; chin and venter smooth with a large disc on venter; posterior part of ventral surface of thighs finely granular or areolar as is the mesial region below vent.

Color in life: Generally dark olive-green, the arms of a lighter shade than body; a large brownish-black spot between eyes extending on to occiput; black stripes extend partly over or along side the dorsolateral glandular fold; back with an irregular series of black rounded spots; a black line on canthus; a black spot in front of tympanum; a line from eye above tympanum runs back and then down behind tympanum; some lateral black spots; a stripe on back of upper arm and one under forearm; femur and tibia with irregular darker transverse bars; under surface of tarsus and foot blackish; posterior surface of thigh indefinitely reticulated. Venter grayish white, the pigment very sparse; lower lip darker with small cream spots. Tympanum brown. (In males chin darker.)

Measurements in mm.: Snout to vent, 90; head width, 29; head length, 33; axilla to groin, 34; arm, 42; hand, 20; leg, 133; tibia, 43; foot and tarsus, 62.

Variation: Some of the males have only the posterior part of the lateral glandular fold. In males the arm above is very light green in life; and in preservative it is brownish gray. The upper surface of the hand is gray-white.

Remarks: The species behaves like, and has the same general appearance as *Rana pipiens*; they may be readily distinguished at a glance by the absence of webbing on the feet. I believe these specimens constitute the first Costa Rican record for the species.

Eggs are laid in masses of foam, large enough to fill more than a liter container. These masses are hidden under thick mats of grass

or weeds or under the edge of a fallen log in the immediate vicinity of water.

Eleutherodactylus florulentus (Cope)

Figure 7

Lithodytes florulentus Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 336-337 (type locality, Boruca, Costa Rica.).

Eleutherodactylus florulentus Taylor, Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952, pp. 765-766.

In 1952 I was successful in rediscovering this species known for the last fifty years from presumably only the single damaged type specimen. It belongs in the section of the genus to which *Eleutherodactylus rugosus* (Peters) belongs. It may be doubted that

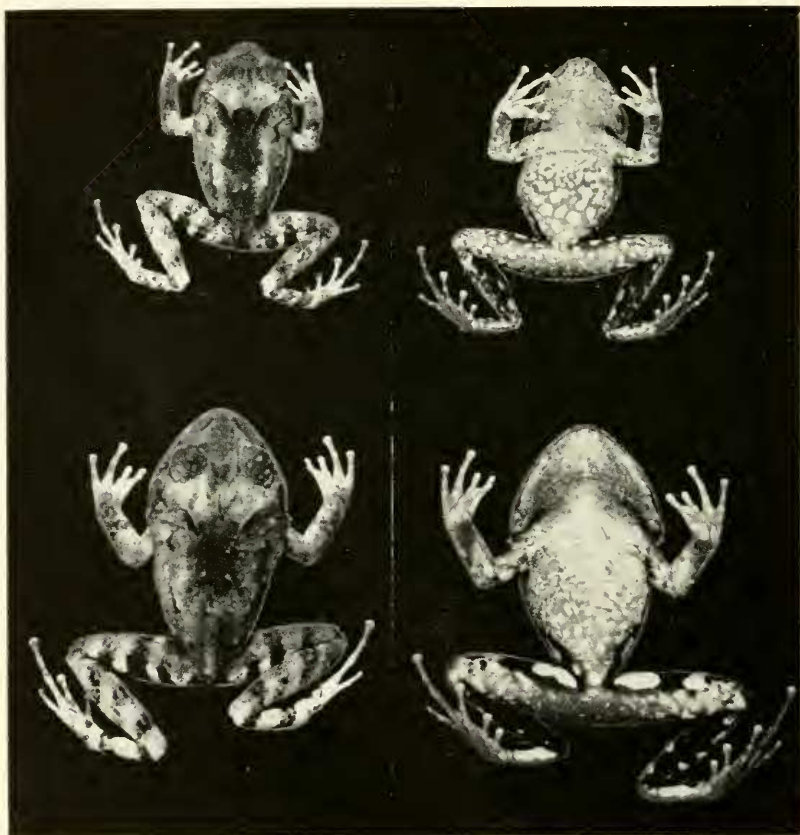


FIG. 7. *Eleutherodactylus florulentus* Cope. Upper, Dorsal and ventral views of K.U.M.N.H. No. 34908. Actual snout-vent length, 33 mm. Lower, Dorsal and ventral views of K.U.M.N.H. No. 34909. Actual snout-vent length, 44 mm.

it reaches a size comparable with that species. The type has the integument of the head destroyed and the typical cranial features have not been recorded. The largest specimen (K.U.M.N.H. 34909) of those taken, has the canthus rostralis very distinct, while the type description says it is not distinct. The description of this specimen follows:

Description: Head very broad, its width a little greater than its length, and equal to more than half length of body; snout oval in outline seen from above; canthus rostralis distinct, top of snout flat, roughened with tubercles; upper part of loreal region declivous then sloping obliquely to lip, leaving the region somewhat concave; eyes moderate, strongly elevated, width of an eyelid greater than inter-orbital width; a pair of bony ridges beginning in anterior interorbital region extend to back of occiput, separated by a shallow depression; eye length (6.1 mm.) greater than its distance from nostril (5 mm.) but almost equal to length of snout (6.2 mm.); tympanum large, distinct, its length 5.6 mm. separated from eye by a distance less than half its diameter; a strong tubercular fold from eye passes across upper edge of tympanum and curves down, not reaching its lower level. A pair of bony knobs behind eye on back edge of occiput. A strong pyramidal tubercle at lower posterior edge of tympanum; choanae rather small, largely lateral, separated from each other by a distance three times diameter of one; vomerine teeth in two thick fascicles well behind level of choanae, closely approximated mesially, not reaching inner level of choanae; palatal glands open into several pores between choanae at their anterior level. Tongue small, sub-circular, notched behind, a small free edge borders posterior parts; openings of the vocal sacs small, short, back behind tongue near jaws; openings of Eustachian tubes small.

A pair of strong dermal ridges begin on the bony bosses behind eyes, and converge, stopping midway of back, but scattered tubercles following suggest a pattern that continues to pelvis; an irregular dorsolateral fold and on back above these are numerous warty tubercles or short ridges; sides warty or tubercular; venter smooth except as lateral granules encroach on sides; chin granular; much of surface under thighs, as well as a region behind vent, granular; hand free, the digits without lateral ridges, the tips widened with transverse terminal grooves; first finger longer than second; an inner metacarpal tubercle and a bifid palmar tubercle; foot with a trace of web, especially between the third and fourth toes; tips of toes with terminal discs, wider than those on fingers; a strong inner meta-

tarsal tubercle and a small but distinct outer; subarticular tubercles distinct; three supernumerary tubercles or swellings on hand, none on foot. Undersurface of hand, foot, and tarsus, glassy smooth; an indistinct inner tarsal fold; tibiotarsal articulation reaches beyond eye but does not reach nostril; when legs are folded at right angles to body heels do not touch; dorsal surface of tibia, femur, back and arms with scattered tubercles.

Color in life: Grayish brown to blackish brown with a lighter area on occiput between supratympanic folds. Arm gray brown with two indistinct darker bands. Leg brownish dorsally, the front and posterior face of femur dark black with the black and red-orange to scarlet interdigitating; in groin two large spots on femur and one on body yellow cream; on front face of thigh, bands of black (fading to brown) and pinkish fawn; a large triangular black spot involving vent and extending behind and below it; sole and under surface of digits and tarsus black; venter reticulated with darker and lighter; side of throat dusky. The figures show the details of the markings.

Measurement in mm.: K.U.M.N.H. Nos. 34909 ♂ and 34908 ♀. Snout to vent, 44, 33; head width 23, 16.7; head length 22.5, 15.6; axilla to groin 19.6, 15.2; arm 30.6, 20; hand 12, 10; leg from vent 73, 54; tibia 23, 17; foot and tarsus 31, 24.*

Remarks: Any discrepancies between the description of this specimen and the type description may be due to age and the mutilated condition of the type. The town of Boruca lies south of San Isidro del General in the lower drainage of the same river—the Río Diquis.

Specimens were obtained as follows: Nos. 34910-34919, Nos. 34920-34922, Las Esquinas; 34923, Golfito, localities in southern Puntarenas Province.

Hyla moraviaensis Taylor

Hyla moraviaensis Taylor, Univ. Kansas Sci. Bull. vol. 35, pt. 1, no. 5, July 1, 1952, pp. 865-868, fig. 57. (Moravia [de Chirripo] Costa Rica.)

This small hyla was found to be common at the type locality in the period June 19-26, during which time a series of 40 specimens were taken. On Aug. 1, 1952 a single specimen was taken from a rivulet draining into the Reventazón across the river from the Inter-American Institute of Agriculture near Turrialba.

* Cope gives the length of foot 24. I suspect that the measurement of the foot of the type is incorrect. This is probably the length of foot and tarsus. Tarsus 9.

The largest female taken measures 44 mm. snout to vent, which is considerably larger than the type. The two largest male specimens reach a length of 32 mm. snout to vent, while most males are less than 30 mm. in length. The five largest females, all gravid, have the following measurements: 37, 39, 39, 40, 44. No eggs were being deposited, and only a single pair was found clasping, between June 19 and June 26.

Hyla staufferi Cope

Figure 8

Hyla staufferi Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 195, (type locality Orizaba, Veracruz).

This species has not heretofore been reported from Costa Rica although presumably it is known from Panamá. I obtained two



FIG. 8. *Hyla staufferi* Cope. Left. K.U.M.N.H. No. 32157 ♂. Actual snout-vent length, 25 mm. Right. K.U.M.N.H. No. 32158 ♀. Actual snout-vent length, 28 mm.

specimens, July 29, 1952, a male and female from under bark of a small tree growing at the edge of a pool at Maribella Hotel at the mouth of the Barranca River, western Costa Rica. These two specimens, herewith figured, are K.U.M.N.H. No. 32157, a male, and No. 32158, a gravid female. A third specimen, No. 32159 ♂, is from

Tenorio, Las Cañas, Guanacaste, Costa Rica, taken at night on a cactus stem, near a small swampy area. Whether this lowland species is present on the eastern coast of Costa Rica has not been determined.

Hyla richardtaylori nov. nom.

Figure 9

Hyla richardi Taylor, Copeia 1948, no. 4, Dec. 31, pp. 233-234 (2 mi. west, Isla Bonita, Caribbean slope Volcán Poás, Costa Rica.)

This very striking species of *Hyla* described by me in 1948, was named *richardi* after Richard Clark Taylor who discovered the unique type. This summer in Harvard I came across the type specimen of *Hyla richardi* Baird, and learned for the first time that the name was preoccupied for *Hyla*, despite the fact that the name is listed in the synonymy of *Hyla versicolor* in Cope's Batrachia of North America, and is likewise given in the list of type specimens in Harvard. Boulenger has omitted the name in his catalogue. In



FIG. 9. *Hyla richardtaylori* nov. nom. Type. Actual snout-vent length, 71 mm.

order to carry out my intention of naming the species for its discoverer, I propose the name *Hyla richardtaylori*.

No other specimen of this large *Hyla* has been discovered. I believe it to be confined to the high mountain forest areas of the northern part of Costa Rica.

Hyla alvaradoi Taylor

Hyla alvaradoi Taylor, Univ. Kansas Sci. Bull., vol. 35, pt. I, no. 5, July 1, 1952, pp. 882-885, fig. 63 (type locality, Moravia [de Chirripo], Costa Rica.)

I collected two more topotypic specimens of *Hyla alvaradoi* at Moravia de Chirripo, within a few meters of the exact type locality. The specimens were calling at intervals from low shrubs along a rivulet at night.

The color of one in life, (K.U.M.N.H. No. 31864) was as follows: Head generally washed in bluish green, the top greenish; throat definitely bluish about vocal sac, the mental swelling yellowish. Back greenish yellow, with yellow lines on canthi extending to eye; a yellow line above vent; bluish on knees; a whitish or yellowish white area on abdomen; concealed parts of limbs indefinite flesh color with very slight pigmentation; under surface of fingers yellowish, under toes whitish flesh. This was captured on the night of June 20, 1952.

No. 31865. Bright yellow green above, canthal lines yellow becoming cream above eyes; eyes bronzy brown; throat and concealed parts of limbs bluish flesh; under both hands, feet and digits, canary to lemon yellow; two lateral areas, clear yellow; dorsal part of limbs flesh, slightly tinted lemon yellow; edge of anal arch cream. This was taken June 24, 1952.

After preservation the colors largely disappeared within 48 hours and the specimens now are cream white with some fine purplish dots scattered on head and back, thus resembling the type.

Hyla Boulengeri Cope

Scytropsis Boulengeri Cope, U. S. Nat. Mus. Bull. No. 32, 1887, pp. 12-13 (type locality, Nicaragua).

The presence of this species in the Caribbean drainage of Costa Rica is confirmed by a specimen No. 24741 taken by me at Turrialba in 1947. Three specimens taken by me on the Dominical Road about 15 miles WSW of San Isidro del General, prove its presence also in the Pacific drainage. Compared with the Turrialba specimen, a number of small differences are evident in these three specimens from the west. In specimens of equal length the tibiotarsal

articulation extends to or slightly beyond the tip of the snout, the femora are longer, the digital pads are observably larger. When legs are folded at right angles the heels overlap a much smaller distance and the body is less slender with a broader head. To determine the extent to which these differences are constant, it will be necessary to examine larger series from both drainage systems. The measurements are compared on the following table:

Measurements of Hyla boulengeri (in mm.)

Number K.U.M.N.H.	24741	34106	34104	34105
Sex	♂	♂	♂	♂
Snout to vent	45	45	46.4	47
Length of head	16	17	18	18
Width of head	14.5	15.3	16	16
Tympanum	3	3	3	3.1
Length of eye	4.1	4.4	4.5	4.55
Eye to median tip of snout	7.7	9	8.9	9.1
Eye to nostril	5.85	6.25	6	6.4
Interorbital distance	4	6	5.2	5.1
Arm	23	24	28	28
Hand	12.3	14.1	14.3	14.4
Width of terminal pad	2	2.8	3	2.8
Leg	66	75	75	77
Femur from vent	19	22	23	23
Tibia	24	26	25.2	27
Foot and tarsus	30	32	32.1	33.3
Heels overlap	7	6.1	5.8	5

Hyla wellmanorum Taylor

Hyla wellmanorum Taylor, Univ. Kansas Sc. Bull., vol. 35, pt. 1, no. 5, July 1, 1952. (Type locality, Bataan, Limon Province, Costa Rica.)

This species, heretofore known by the type series consisting of four specimens from Bataan and Los Diamantes, Limón Province, is represented in the 1952 collections by three more specimens from the following localities: K.U.M.N.H. No. 32169, La Lola, No. 32171, Tunnel Camp, near Peralta, and No. 32170, Los Diamantes, all from Limón Province, Costa Rica. All three of these specimens show the typical markings and color of the type.

Hyla rosenbergi Boulenger

Figures 10, 10a

Hyla rosenbergi Boulenger, Proc. Zool. Soc. London, 1898, Feb. 15, p. 123, pl. 16 (type locality, Cachabé, western Ecuador); Nieden, Das Tierreich; Amphibia, Anura I. Subordo Aglossa und Phaneroglossa, Sectio I, Arcifera 1923, pp. 264-265 (translation of type description). Breder, Nat. Hist. (New York), vol. 25, no. 4, July-Aug. 1925, pp. 324-337 (Breeding habits) photographs; Bull. Amer. Mus. Nat. Hist., vol. 86, art. 8, Aug. 26, 1946, pp. 375-436, pp. 42-60, numerous figs.

This species came to my attention from a specimen taken from the window of an airplane at Golfito, Costa Rica, by Stuart Baker, August 12, 1952. It was presumed that the frog had been picked up by the plane as it taxied into position for a take-off.

A second specimen, a male was found near Palmar, Sept. 2, 1952 (across river in low mountains), by following a frog call. It was sitting at the edge of a tiny rain pool in a depression near a rivulet—a pool about 1½ feet across. A third specimen was found in a small pool in an open field close to Palmar by John Baker, Sept. 3.

On September 6, we moved south to Golfito, where on the previous day there had been a heavy rainfall. In an area by the edge of the airfield where the grass had been cleared for a golf course, we found *Hyla rosenbergi* in considerable numbers at night. Males were in small water-filled depressions from one-half to one and one-half feet wide; the females were usually hidden nearby in piles of cut grass. One or two pairs were clasping but neither on this or the subsequent nights, Sept. 7-11, did we find any eggs deposited.

As we approached the area calls ceased and the frogs slipped under the surface of the water; but the pools containing frogs were discerned easily since the water showed a very milky color from disturbed sediment, while the other pools contained only clear water.

This series, I believe, represents the northernmost collections of the species. Mr. Breder has reported its presence in Darién, Panamá. No Costa Rican specimen was available to me when I prepared my review of the Costa Rican frogs.

Diagnosis: A large frog reaching a length (in female) of 97 mm., with a distinct prepollex, less conspicuous in female, more distinct in male and terminating in a sharp curved spine available for clasping (see Fig. 10a); male with an elongate lateral gland extending more than half of the length between axilla and groin; diameter of tympanum three fourths of the length of eye; length of eye much shorter than snout; outer fingers webbed for four fifths of their length; toes almost completely webbed; tibiotarsal joint extends much beyond snout; inner and outer tarsal folds nearly obsolete; digital pads large but less than tympanum in diameter; vomerine teeth forming angulate series between large, somewhat angular choanae.

Description of species: (From K.U.M.N.H. No. 31849 Golfito, Costa Rica, female.) Length of head (23.8 mm.) slightly less than width (25 mm.); top of head flat, the eyes elevated prominently;

canthi blunt, curving, rather closely approximated posterior to nostrils; top of snout widening above nostrils which are narrowed and nearly vertical; loreal region sloping broadly with a shallow depression; in front of nostrils the snout turns down leaving nostrils within two millimeters of front point of snout and much closer to median point on upper lip than to eye; narrowest interorbital distance (8 mm.) equals distance between eye and nostril; tympanum large,



FIG. 10. *Hyla rosenbergi* Boulenger. K.U.M.N.H. No. 31849, Golfito Puntarenas Province, Costa Rica. Actual snout-vent length, 75 mm.

very distinctly pigmented, its greatest diameter (5.4 mm.) much less than the length of eye (7.3 mm.); distance between tympanum and eye 2.2 mm.; width of upper eyelid about equal to interorbital width.

Choanae very large, angular anteriorly; vomerine teeth in two elevated, angular series close to inner edge of choanae, the elevations separated mesially by a distance not exceeding the diameter of two teeth, 17 or 18 teeth in each series; openings of the palatal

glands in a transverse groove, separated from front edge of palate by a distance half that between groove and anterior level of teeth; tongue broad, subcircular, entirely adherent on borders save a free edge behind, one seventh of its length; (males with elongated vocal slits extending well under back part of tongue); half of forearm extending beyond tip of snout; outer fingers connected with a web extending four fifths of length of digits; not more than one-fourth webbed between first two fingers; an elongate metacarpal tubercle at base of first finger; a large outer metacarpal tubercle partly divided; pollical remnant small (larger in males); distal subarticular tubercles single; some supernumerary granules on palm; leg long,

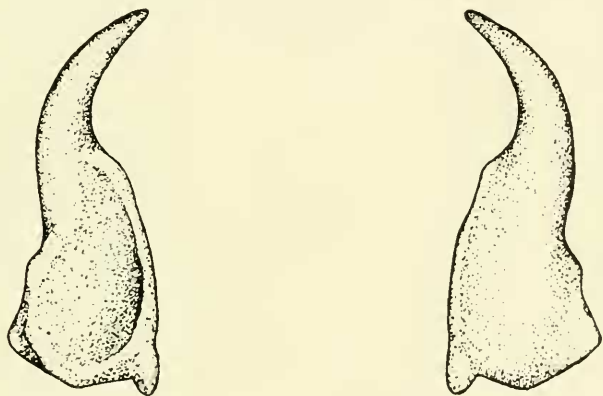


FIG. 10a. *Hyla rosenbergi* Boulenger. Pollical spine on male; dorsal and ventral views.

the tibiotarsal articulation reaching five millimeters beyond the tip of snout; toes almost fully webbed; a large flat inner metatarsal tubercle, no outer tubercle present; inner tarsal fold obsolete; outer fold not or scarcely indicated.

Skin above showing minute corrugations distinct under a lens; throat and chin indistinctly covered with minute granules; breast venter and under thighs with small nearly uniform granules, skin on front and back of thighs smoother; a few indistinct tubercles below vent, and a pair of indistinct ridges forming a vertical groove; a tubercular skinfold on posterior edge of forearm.

Color: Above brown with a median black line from tip of snout to rump; an indistinct black reticulation on back, sides and limbs with some black irregular darker markings; lines on sides somewhat vertical; immaculate white below; arms with small darker blotches,

legs with large spots, one on thigh, two on tibia; under part of digital webs dark; terminal pads light.

Measurements of Hyla rosenbergii

Number	31849	31847	31857
Sex	♀	♀	♂
Snout to vent	75.0	76.0	71
Length of head	23.8	23.5	24
Width of head	25.0	25.2	24
Eye length	7.3	7.1	7
Eye to tip of snout	11.0	11.4	11
Interorbital width	8.0	8	7
Diameter of tympanum	5.4	5.1	5
Arm	46.0	45.0	43
Hand	23.0	23	22.2
Leg	130.0	133.0	123.0
Tibia	43	46	41.5
Foot and Tarsus	56	58	51

Variation: Compared with the type description the Costa Rican specimens are very considerably smaller than the type (97 mm.). The fourteen males average 70.7 mm. in length ranging from 66-72 mm. (seven of fourteen specimens having a measurement of 72 mm.). The females, 7 in all, average 73.5 mm., and vary from 72-76. Thus the length of the type exceeds our largest specimen by 21 mm.

The specimens vary considerably in markings. Females are usually much lighter, some being fawn with little or no markings save a black median line; in others the reticulation is delicate and the darker spotting on the back and banding on legs is scarcely visible. The males are darker, usually gray-brown or blackish with lighter marbling, but in these the banding on limbs may be either distinct or indistinct.

The species seemingly is well established in Costa Rica and presumably has been so for a long period of time. Presumably its northward movement is limited to the southwestern area of very heavy rainfall. The elevation at which these specimens were taken is only a few meters above sea level.

Hyla manisorum sp. nov.

Figure 11

Type: K.U.M.N.H. No. 34927 ♀. Collected at Bataan, Limón Province, Costa Rica, July 22, 1951; Edward H. Taylor, collector.

Diagnosis: A large frog (female 76 mm.), head skin free, a smooth back, toes a little more than one-third webbed; the terminal discs of

digits much smaller than tympanum which is two thirds to three fourths of eye. Canthus sharp; chin and breast smooth, granular on vent and posterior infrapleural area; an inner tarsal fold; vomerine teeth in two distinctly triangular areas between large choanae, the teeth forming two rows converging anteriorly.



FIG. 11. *Hyla manisorum* sp. nov. Type. K.U.M.N.H. No. 34927 ♀ Bataan, Costa Rica. Actual snout-vent length 76 mm.

Description of the type: Profile of head seen directly from above a rounded oval, the length (25 mm.) less than its width at tympanum (29 mm.); canthus rostralis strongly defined, nearly straight, converging somewhat; area about nostrils somewhat elevated, with a slight depression between them; in lateral profile the snout sloping forward and curving back slightly so that nostrils almost reach

anterior level of lip, snout projecting beyond line of mouth about two millimeters; upper part of loreal region nearly vertical, lower part sloping rather abruptly to lip; whole loreal region somewhat concave; eye rather prominent its length (8 mm.) greater than its distance from nostril (6.3 mm.) but less than length of snout (9 mm.); tympanum large, distinct, subcircular, its diameter (6 mm.) equal to three fourths of eye length; tympanum separated from eye by a distance of 3.2 mm.; a distinct fold from eye curving above tympanum covering its upper edge and running down to jaw angle; a branch from it forms a small fold running back above arm (and may be continued farther); interorbital and much of occipital area with a shallow depression, the skull slightly elevated into two slight indistinct ridges beginning behind eyes and converging on back of skull. Width of an eyelid one and one-third times in interorbital distance.

Tongue subcircular, very slightly emarginate behind, not or but very slightly free behind and on sides; palatal glands opening through a series of slitlike pores; elevated triangular ridges supporting vomerine teeth reach anterior elevated rim of choanae (or nearly so), the teeth on their posterior edges form two diagonal converging lines separated mesially by a distance equal to distance from choanae; the inner rim of choanae (seen from below), is strongly depressed thus forming a depression between dental elevations and choanae. Openings of Eustachian tubes large, transversely widened, equal or of perhaps a little less than choanae in area.

Arm moderately long, nearly half of forearm reaching beyond mouth; no trace of a pollical spur or rudimentary pollex; web remnant between first and second fingers; other fingers between one-third and one-half webbed; discs rather well developed but distinctly smaller than tympanum; subarticular tubercles single; the inner metacarpal and palmar tubercles present, the latter however very ill defined; supernumerary tubercles not well defined; the row of tubercles under arm almost obsolete.

Leg rather short, tibiotarsal articulation reaching to front edge of eye; when legs are folded heels touch but do not overlap; when arm and leg are adpressed, knee and elbow are separated; toes nearly four-fifths webbed, discs only slightly smaller than those on fingers; a rather small inner metatarsal tubercle, the outer cannot be discerned and is probably absent; a well-defined inner tarsal fold beginning somewhat above tubercle, and reaching heel.

Skin smooth on head and dorsal parts of limbs and body; sides with a fine reticulation becoming more granular on venter; chin and

breast smooth; medial posterior part of under surface of thighs granular; vent with a very small flap, the opening on a vertical level with the posterior face of thighs.

Color in life: A rather dull brown above, grayish brown on sides becoming cream on ventral surfaces; posterior face of femur slightly darker with a faint suggestion of some lighter clouding or flecking; front of thigh and groin area brown with most indefinite cream flecks; tympanum more uniform, perhaps darker brown; on back several faintly browner flecks or spots; scattered pigment on under surface of foot, tibia, tarsus, and to a less extent, on the hand also.

Measurements in mm.: Snout to vent 76; width of head 29; length of head 25; length of snout 9; arm 45; hand 24; leg 121; tibia 40; tarsus 22; foot 33.4.

Remarks: This large specimen was found in a small rain pool during a heavy rain, at Bataan. In a nearby, but inaccessible tree, I heard an unrecognized, raucous frog call which I suspected might belong to this species. No others were heard while in Bataan.

I am uncertain as to the closest relative of this form.

The species is dedicated to my friends Mr. and Mrs. Eugene Manis of Los Diamantes, my hosts on numerous occasions, companions on collecting trips, and donors of numerous specimens to the collections.

Hyla weyeræ sp. nov.

Type: K.U.M.N.H. No. 34850; from Esquinas Forest Reserve at Las Esquinas, between Palmar and Golfito, Puntarenas Province, Costa Rica. Oct. 1952, Mrs. Albert E. Weyer, collector.

Diagnosis: A small species with strong axillary webs, the webs attached on arm to near elbow; tibiotarsal articulation to slightly beyond tip of snout; outer fingers nearly one-half webbed; toes nearly completely webbed; femur pigmentless except for a few chromatophores near knee; a strong inner tarsal fold; subarticular tubercles on outer fingers double; chin and breast smooth, venter granular; vomerine tooth fascicles smaller than choanae. Color in life, bright yellow; in preservative reddish brown, the venter cream white with a large cream spot below eye.

Description of type: Head large, much wider than body; snout truncate, the canthal edge somewhat rounded but distinct; lores nearly vertical, sloping abruptly to lip, the region not or but slightly concave; area about nostrils not or but little swollen, no depression between; head a little wider than long; eye moderately elevated

extending out beyond jaw outline, its length (4 mm.) greater than length of snout (3.35 mm.); distance from eye to nostril 3 mm.; tympanum rather small (1.3 mm.), approximately one third of eye length; a fold from eye crosses its upper surface curving down considerably behind tympanum but scarcely reaching below the level of its middle; tympanum separated from eye by a distance greater than its diameter; a slight depression in frontal area; width of an eyelid in interorbital distance one and one-fifth times. Tongue (distorted) probably subcircular, not or scarcely free behind, and probably somewhat emarginate; a pair of small rounded ridges bearing very minute teeth lying between anterior halves of choanae, the groups less than half size of choanae, and separated from each other and the choanae by a distance equal to length of one ridge; openings of palatal glands in a groove much closer to choanal level than to front of palate; diameter of choana in distance between choanae approximately three times. Arm short, inner finger more or less opposed to other fingers, terminal discs much larger than tympanum; first two fingers one-fourth (or a little more) webbed; outer fingers nearly half webbed; the toes slightly fringed to discs; a fold on outer edge of fourth finger; inner metacarpal tubercle strong; palmar tubercle elongate but indistinct; no row of tubercles under arm; subarticular tubercles on two outer toes double; groove on edge of discs preceded by a free fringe, wider than is usually present in hylid frogs; leg long, tibiotarsal articulation reaching a little beyond tip of snout; legs, when folded at right angles, having heels overlap about eight millimeters; toes nearly completely webbed, the discs smaller than those on fingers but still larger than tympanum; inner metatarsal tubercle moderate, outer tubercle relatively very large; a distinct inner metatarsal fold.

Skin shiny smooth above; chin smooth, and without a fold on breast; venter covered with large granules; greater part of under surface of thigh granular; region below vent slightly granulate; a very strong axillary web which attaches along posterior face of arm to near elbow, and extends along side to near groin.

Color: In life "completely yellow" above; in preservation the dorsal surface is very light reddish brown rather distinctly separated from cream color of ventral surface of chin, breast, body and limbs; the brown color of limbs is confined to dorsal surfaces only; and on digits to outer finger and two outer toes; chin and lower lip completely cream; a large cream spot below eye but much longer than eye; front edge of upper lip brown; a darker brown stripe from eye, across tympanum and for some distance along side of body.

Measurements in mm.: Snout to vent 33; width of head 11.5; length of head 9.5; arm 21.2; hand 10; leg 60; tibia 20; tarsus 12; foot 17.

Remarks: This small species may belong in the group of small frogs that includes *Hyla alleei*, *Hyla rufocula*, and *Hyla uranochroa*, but differs from all in the presence of the extensive webbing in the axilla and the greater length of the hind limb.

The species is dedicated to Mrs. Albert E. Weyer formerly of Golfito who discovered and preserved the type, and, together with other rare forms, presented it to the University of Kansas collections.

Rana palmipes Spix

Figure 12

Rana palmipes Spix, Animalia nova, sivi species novae testudinum et ranarum quas in itinere per Brasiliam. . . . 1824, p. 5, pl. 5, fig. 1 (type locality Brasil).

Rana palmipes hoffmanni L. Müller, Mitteil. Zool. Mus. Berlin, Bd. 11, Heft 1, June, 1924 p. 80 (type locality, Costa Rica).

Lorenz Müller, in 1923, after a comparison of a Costa Rican specimen collected by Hoffmann, with the type specimen of Spix, in 1923 designated the Costa Rican form of *Rana palmipes* as a new subspecies, differing from the Brazilian typical form in having a slenderer body, smaller head, sharper and longer snout, smaller inter-orbital width, and a more strongly developed web between digits.

This species has had numerous subspecies proposed. Peters, who presumably had available the Spix type, named three species or subspecies—*Rana affinis* Caracas, Venezuela, *Rana gollmeri* Caracas, Venezuela, and *Rana clamata guianensis*; but later he placed the first two in synonymy of *Rana palmipes*. Cope described two new species *R. brevipalmata* (preoccupied and renamed *copii* by Boulenger) and *R. nigrilatus*, both from Nauta, Perú. Fowler named an Ecuadorean form, *R. brevipalmata rhoadsi*, Brocchi named a British Honduran form *Rana vallianti*, and Günther named *Rana bonaccana* from Bonaccana Island (off British Honduras) and *Rana melanosoma* from Duenas, Guatemala, and Nicaragua, 3,250 ft. elev. Boulenger in 1920 placed all of these forms listed, in the synonymy of *palmipes*. He is followed by Kellogg, 1927, who admits the possibility that some of these forms may warrant recognition. Both authors point out that most of the nominal species are based upon very young specimens.

The form described by Müller was not listed either by Kellogg or Boulenger. The characters pointed out may serve to distinguish

it from Amazonian specimens but whether it is distinguishable from species described from Nicaragua or Ecuador, is still to be proved.

The photograph here given is of a specimen K.U.M.N.H. No. 30466), 73 mm. in length.



FIG. 12. *Rana palmipes* Spix. K.U.M.N.H. No. 30466. Turrialba, Costa Rica. Actual snout-vent length 73 mm.

ERRATA

Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952. The Frogs and Toads of Costa Rica.

Page 601, line 24, for *head* read *neck*; p. 657, 1, 11, before *Costa Rica* insert *Bebedero*; p. 660, 1, 16 for *of* read *on*; p. 688, 1, 17 inclose *female* in parentheses; 1, 47, before *dises* insert *toe*; p. 777, 1, 23 for *Alejuela* read *Alajuela*; p. 798, 1, 20, for *on* read *or*; p. 913, 1, 36 for 1939 read 1839; p. 922, 1, 36, for *as* read *are*; p. 923, 1, 3, for *Phyrnohyas* read *Phrynohyas*.

BIBLIOGRAPHY

BOULENGER, GEORGE A.

1898. An account of the reptiles and batrachians collected by Mr. W. F. H. Rosenberg in western Ecuador. *Proc. Zool. Soc. London*, Feb. 15, 1898, pp. 107-126, pls. 10-18.

BREEDER, C. M., JR.

1925. In Darien jungles, experiences of a student of reptile and amphibian life in a little-known part of Panama. *Nat. Hist.*, vol. 25, 1925, pp. 324-337.
1946. Amphibians and reptiles of the Rio Chucunaque drainage, Darien, Panama, with notes on their life histories and habits. *Bull. Amer. Mus. Nat. Hist.*, vol. 86, 1946, pp. 381-435, pls. 42-60, text figs. 1-25.

BROCCHI, M.

- 1881-1883. Étude des batraciens de l'Amérique Centrale. *Mission Scientifique au Mexique et dans l'Amérique Centrale*, livr. 1-3, 1881-1883, pp. 1-122, pls. 1-21, and 17 bis, 18 bis, 20 bis.

COPE, EDWARD D.

1865. Third contribution to the herpetology of tropical America. *Proc. Acad. Nat. Sci. Philadelphia*, 1865, pp. 185-198.
1874. On some batrachia and nematognathi brought from the upper Amazon by Prof. Orton. *Proc. Acad. Nat. Sci. Philadelphia*, 1874, Sept., pp. 120-132.
1877. Tenth contribution to the herpetology of tropical America. *Proc. Amer. Philos. Soc.*, vol. 17, Aug. 15, 1877, pp. 85-98.
1887. Catalogue of the batrachians and reptiles of Central America and Mexico. *U. S. Mus. Bull.* 32, 1887, pp. 1-99.
1893. Second addition to the knowledge of the batrachians and Reptilia of Costa Rica. *Proc. Amer. Philos. Soc.*, vol. 31, 1893, Nov. 17, pp. 333-347.

FOWLER, H. W.

1913. Amphibians and reptiles from Ecuador, Venezuela, and Yucatan. *Proc. Acad. Nat. Sci. Philadelphia*, vol. 65, 1913, pp. 153-176, pls. 5-10.

GÜNTHER, ALBERT

- 1885-1902. *Biologia Centralia-Americana. Reptilia and Batrachia.* 1885-1902, pp. I-XX; 1-326, pls. 1-76.

KELLOGG, REMINGTON

1912. Mexican tailless amphibians in the United States National Museum. *U. S. Nat. Mus. Bull.* no. 160, 1912, pp. 1-224.

MÜLLER, LORENZ

1923. Ueber neue oder seltene Mittel-und südamerikanische Amphibien und Reptilien. *Mitteil. Zool. Mus. Berlin*, Bd. 11, Heft. 1, 1923, pp. 75-93.

NEIDEN, FRITZ

1923. *Das Tierreich.* Lief. 46. Anura I. 1923, pp. I-XXXII, 1-584, text figs. 1-380. Berlin and Leipzig, Walter de Gruyter and Co.

NOBLE, GLADWYN K.

1918. The amphibians collected by the American Museum Expedition to Nicaragua in 1916. Bull. Amer. Mus. Nat. Hist., vol. 38, art. 11, June 20, 1918, pp. 311-347, pls. 14-19.

PETERS, W.

1859. Eine neue Gattung und eine neue Art von Fröschen aus Carácas vor. Monatsb. Akad. Wiss. Berlin, 1859, pp. 402-403.
1863. Ueber ein neue Schlangengattung *Styporhynchus* und verschiedene ander Amphibien des zoologischen museums. Monatsb. Akad. Wiss. Berlin, 1863, pp. 399-413, pls. 1-7 (1864).
1873. Ueber eine neue Schildkrötenart, *Cinosternon Effeldtii* und einige andere neue oder weniger bekannte Amphibien. Monatsb. Akad. Wiss. Berlin, 1873, pp. 603-618.

SPIX, JEAN B. VON

1824. Animalia nova, sive species novae testudinum et ranarum quas in itinere per Brasilliam annis 1817-1820 collegit et discripsit fasciculus. 1824, 4to, Monachii.

TAYLOR, EDWARD H.

- 1948a. New Costa Rican salamanders. Proc. Biol. Soc. Washington, vol. 61, Nov. 12, 1948, pp. 177-180.
- 1948b. Two new hylid frogs from Costa Rica. Copeia, 1948, no. 4, Dec. 31, pp. 233-237, text figs. 1, 2.
- 1949a. Two new Teiid lizards from Costa Rica. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 5, Apr. 20, 1949, pp. 271-278, text figs. 1, 2.
- 1949b. New salamanders from Costa Rica. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 12, Apr. 20, 1949, pp. 279-288.
- 1949c. Costa Rican frogs of the genera *Centrolene* and *Centrolenella*. Univ. Kansas Sci. Bull., vol. 33, pt. 1, no. 4, Apr. 20, 1949, pp. 257-270.
- 1951a. Two new genera and a new family of tropical frogs. Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, pp. 33-40.
- 1951b. A brief review of the snakes of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 1, no. 1, Oct. 1, 1951, pp. 3-188, pls. 1-23, text figs. 1-7.
- 1952a. The salamanders and caecileans of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 2, no. 12, Feb. 15, 1952, pp. 695-791, pls. 76-88, text figs. 1-14.
- 1952b. A review of the frogs and toads of Costa Rica. Univ. Kansas Sci. Bull., vol. 35, pt. 1, no. 5, July 1, 1952, pp. 577-942, text figs. 1-69.

